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Gun-Pointing Vector Instrumentation System Is Revolutionary, Portable, Rugged

Measurement of gun-pointing accuracy has long been a challenge to those who must assess the highly sophisticated fire-control systems now pointing our most advanced weapons. The technology offered by laser rangers and high-speed computers no longer measure accuracy in yards, but in tenths of an inch. These accuracies are being achieved at U.S. Army Yuma Proving Ground (YPG) via instrumentation known as the Gun-Pointing Vector Instrumentation System (GPVIS).

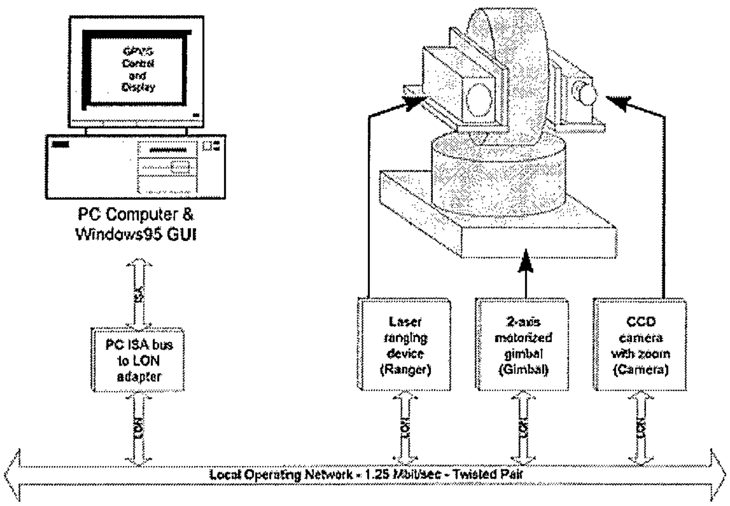
The GPVIS program has taken an evolutionary path that led from the original concept of triangulation technique to a trilateration technique. The original GPVIS concept was a high-resolution optical imaging system that uses triangulation to precisely measure small changes in gun barrel position, distortion, pointing, and alignment. It was intended to use high-resolution linear-imaging arrays to minimize the number of imaging pixels, to facilitate data reduction and system networking, and to minimize system costs. This approach, though appealing on the surface, implies a hidden requirement for a robust, shock-hardened, and high-precision gimbaled stage. This requirement puts the triangulation approach on a highly risky path, because no such gimbaled rotary stage is available on a "commercial-off-the-shelf" basis.

Additional and expected, severe test environment effects on the rotary stage, such as shock, make this approach even less attractive and more risky. In December 1995, an alternative approach was proposed, using trilateration rather than triangulation. One unique advantage of trilateration is it relaxes the requirement for a precision rotary stage. Trilateration translates the requirement for angular precision to precise measurements in distance. Precise distance measurements allow the GPVIS to achieve robustness through self-calibration against surveyed-in benchmarks.

GPVIS is a high-resolution, optical imaging system that uses trilateration to measure precisely small changes in gun-barrel position, distortion, pointing and alignment. It uses a low-cost and rugged laser range finder on an automated gimbaled mount to achieve accurate distance measurements and robust operation in a harsh environment. The GPVIS phase 1 program concluded successfully with a concepts demonstration on April 24-25, 1996, at YPG. The overall program is a multiphase, multiyear program, supported by J-Squared LLC, the integrating contractor.

The Phase 1 GPVIS demonstrated in April is depicted in the figure below. The conceptual system was "fielded" in YPG's Building 2067 with comparisons made to known surveyed targets. For the eight

calibration target points the average difference or delta range is 0.08″(2.05 mm) and the standard deviation of the differences is 0.16″(4.09 mm). After making a normalization correction in the measured error with the projected spot area of the laser beam the average difference is 0.04″(0.97 mm) with a standard deviation of 0.08″(1.98 mm). These final error values are consistent with the specified 0.1" accuracy of the ranger and prove the validity of the GPVIS to accurately measure distances.



The phase 1 hardware has one measurement station, called the miniature tracking station (MTS-200), and a computer control and readout system. The networking scheme used here offers a seamless migration path to the final multistation configuration. The MTS-200 consists of the laser range finder, boresight camera, and color charge-coupled-device (CCD) camera with motorized zoom mounted to a 2-axis motorized gimbal platform. Each of these components are retrofitted with a M3150 Neuron processor.

This processor uses a local operating network (LONTalk) protocol and is capable of implementing communications over many physical layer transmission media including power line, radio frequency, infrared (IR) and in this case, 1.25 Mbit/sec twisted wire pair. The twisted wire pair network is extended back to a desktop personal computer (PC) where the LONTalk network is interfaced to the PC ISA bus. The PC operates under Windows 95 Operating System with a Visual Basic (VB) 4.0 graphical user interface (GUI). The VB GUI is chosen for its ease of programming and vast third-party commercial support.

A GUI was demonstrated for control of the GPVIS station and data collection. The GPVIS station includes a two-axis gimbal, laser rangefinder, boresight IR CCD camera, and hi-resolution CCD color camera. The demonstrated GUI is one module of the overall system GUI, which will be subsequently developed in the follow-on phases.

With the successful completion of the concept demonstration, YPG now plans to take GPVIS to a completed, working system via a continuation program. Phase 2 focuses on tasks that would lead to a field-hardened GPVIS station, called MTS-200, with hardened features. It will be tested in a live-fire environment and required hardness features incorporated, including upgrade of the phase 1 prototype. Finally, in phase 2, software will be developed for the complete automation of GPVIS.

In phase 3, a third MTS-200 will be built, fully configured and ready for final system integration with fully automated system and network software. This full GPVIS will undergo a laboratory test and a live-fire field test to verify its operational characteristics. Successful completion of these tests will be the basis for final design and a plan for production.

The engineers at YPG are well on their way to having a rugged new portable gun-pointing measurement system with accuracies heretofore unattainable.

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